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PROTEIN ENERGY MALNUTRITION AS A RISK FACTORS FOR ACUTE DIARRHEA CHILDREN AGED 7-24 MONTHS

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ABSTRACT— More than half of the dead babies, toddlers and is associated with poor maternal nutritional status. The risk of death in children with severe malnutrition 13 times greater than a normal child. This study aimed to analyze the effect of Protein Energy Malnutrition in children aged 7-24 months with acute diarrhea. By using the case control study, 45 children between the age of 7-24 months who suffer acute diarrhea were matched with the same number, age and sex group who did not suffer acute diarrhea. Consecutive sampling was used for those children in Posyandu which were under the supervision of The Ibrahim Adjie Community Health Center, Bandung. Multivariable analysis showed that PEM was a major risk factor contributing to acute diarrhea, with incident risk was 4.2 times in children between the age of 7-24 months with stunting nutrition status compared to the children with normal nutrition status, using nonexclusive breast feeding and bad health environment as controlled variables. The highest risk in acute diarrhea incident (79,4 %), was showed in children between the age of 7-24 months with stunting nutrition status caused by PEM, nonexclusive breast feeding, and unfavorable health environment. On the contrary, the chance of acute diarrhea was smallest (8,7 %) in normal nutrition status, exclusive breast feeding for the first six months and good health environment.

KEYWORDS: Protein Energy Malnutrition, acute diarrhea, exclusive breast feeding, health environment

1. INTRODUCTION

As part of the international community, the direction of national development cannot be separated from the global agenda, as stated in the Millennium Development Goals (MDGs) or the Millennium Development Goals, which are the commitment of each country to significantly reduce poverty and hunger in 2015[1]. Of the 8 (eight) goals The MDGs that were declared and signed by 189 countries in September 2000 contained the indicator "Reducing the prevalence of malnutrition among children under five (fourth indicator) and decreasing the number of people with energy deficits (fifth indicator)" [2]. Although much has been achieved, these joint efforts have recently received serious challenges with climate change due to global warming. The World Health Organization (WHO) estimates that 34% of children worldwide who are currently ill and 36% of deaths in children before the age of 14 are related to climate change. It is suspected that at that age the children are still very sensitive to environmental changes, because the child's body is not yet mature physically, psychologically and cognitively. Climate change increases the risk of illness and death in children due to worsening air quality, and increased growth of infectious vectors[3]. Even though it has ratified the MDGs, it turns out that the quality of Indonesian people when measured by the Human Development Index (HDI) or the Human Development Index (HDI) has not improved. The United Nation Development Program (UNDP) report in 2003 Indonesia's HDI ranks 110 out of 177 countries, then rises two places to 108 in 2004, then the last report in 2005 became 107, which is a lower rank than the HDI ranking of neighboring countries, except for Timor Leste which ranks 150. (Vietnam-105, Malaysia-63, Singapore-25) [4]. The low HDI is influenced by the low nutritional status and health of the Indonesian population, which is shown by the high infant mortality rate of 35 per thousand live births, and the under-

five mortality rate of 58 per thousand live births, and the maternal mortality rate of 307 per hundred thousand births life. More than half of these infant, toddler and maternal deaths are related to poor nutritional status. The risk of dying in children with malnutrition is 13 times greater than for normal children[1,5]. Lack of Protein Energy is influenced by many interrelated factors. It is directly affected by 2 things, namely the child is not getting enough nutritious food, and the child may suffer from infectious diseases[7]. The interaction or synergy between malnutrition and infection is a major cause of morbidity and mortality in children in many countries in Africa, Asia and Latin America. Infection causes the nutritional status to deteriorate, on the other hand, poor nutrition increases susceptibility to infectious diseases[8].

The results of the analysis of the program manager indicate a strong suspicion that PEM cases in Bandung City are related to environmentally based diseases, such as tuberculosis, ARI and diarrhea, which generally develop in densely populated areas with poor hygiene and sanitation quality. This assumption is strengthened by the fact that the high level of population density as a result of the registration of the Bandung City Central Bureau of Statistics 2004[9] is 13,345 people / km^2. Research on the effect of environmental health on the incidence of diarrhea in Riau shows a relationship between poor environmental health and the duration of diarrhea ($p = 0.004$) [10]. On the other hand, in areas with high population density but with good environmental sanitation, as research in Kelurahan Kenjeran, Surabaya, shows there is no significant relationship between environmental sanitation and the incidence of diarrhea in children aged 5 to 14 years[11]. One area in Bandung City with a high prevalence of malnutrition and diarrhea cases is Puskesmas Ibrahim Adjie. In 2005, the prevalence of malnutrition was recorded at 1.48%, above the average for the city of Bandung, although theoretically it has almost reached the target of West Java coverage of 1% Malnutrition in 2005, if you look at the prevalence of total PEM which is still 13.6% potential the threat of increasing the prevalence of malnutrition is still quite large. The coverage of diarrhea sufferers is 868 children under five, or 3 times more than the average in Bandung. The handling of cases of malnutrition under five so far is with the Recovery Supplementary Food (PMT) program, which is allocated for 90 days per case as well as treatment of comorbidities, including diarrhea and other infectious diseases, and referral to hospitals[9]. The research objective was to determine whether protein deficiency is a risk factor for the incidence of acute diarrhea in children aged 7-24 months in the work area of Puskesmas Ibrahim Adjie, Batununggal District, Bandung City.

2. METHODS

Children aged 7-24 months as subjects in this study must meet the inclusion and exclusion criteria. The design of this study was a case-control (case control), with the effect-to-cause paradigm by measuring and comparing the experience of exposure to risk factors, namely PEM, which is thought to be the cause of a disease 13, namely acute diarrhea as an outcome. The sample in this study were some children aged 7-24 months who would be selected using the Consecutive Sampling method and met the inclusion and exclusion criteria, and the sample size was calculated based on the hypothesis testing formula against Odds-Ratio (OR) in a matched sample of 1 case with 1 control (1: 1) [14-2]. For research purposes, the sample size was increased from 27 samples to 45 samples per group on the basis of the 'rule of thumb' consideration, namely to meet the minimum needs of each variable of 10 samples from 9 variables studied, so that the total sample was 90 children. with Consecutive Sampling technique. The final analysis stage is multivariable analysis to measure the size of the risk factor for the independent variable on the dependent variable that is observed simultaneously. In this multivariable analysis, the multiple logistic regression analysis approach is used with the Risk Factor Model. [15-2]

3. RESULT

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3.1 The relationship between the characteristics of children 7-24 months with the incidence of acute diarrhea

The relationship between the characteristics of children 7-24 months with the incidence of acute diarrhea can be explained in table 1

Table 1 shows two variables, namely the gender variable and the child's age variable, which have a p value> 0.25, which means that each of them is not significantly related to the incidence of acute diarrhea. The causes for these two variables are quite clear, because the variables of sex and age of the child are matched variables, with the aim of increasing the precision of the study and controlling for the possibility of being confounding variables. Meanwhile, children with a history of LBW (Low Birth Weight Infants) had the greatest risk of suffering from acute diarrhea, with OR = 5.3 (95% CI = 1.1 - 10.4) and the significance of the relationship was significant (p = 0.02).

Table 1 The Relationship between the Characteristics of Children 7-24 Months with the Incidence of Acute Diarrhea

Variable	Acute diarrhea (n=45)		Not Acute Diarrhea (n = 45)		p-Value	OR (95 % CI)
	f_i	%	f_i	%		
Gender						1,0
Man	17	37,8	17	37,8	1,0	(0,4 – 2,3)
Woman	28	62,2	28	62,2		
Age (month)						0,9
7 – 12	17	37,8	18	40,0	0,8	(0,4 – 2,1)
13 – 24	28	62,2	27	60,0		
PEM (Height/U)						4,2
Short	26	57,8	11	24,4	0,001	(1,7 – 10,4)
Normal	19	42,2	34	75,6		
Low Birth Weight						5,3
< 2500 Grm	9	20,0	2	4,4	0,02	(1,1 – 26,5)
≥ 2500 Grm	36	80,0	43	95,6		

3.2 Relationship between Families of Children aged 7-24 months and the incidence of acute diarrhea.

The relationship between family characteristics and the incidence of acute diarrhea can be explained in Table 2.

Table 2 The Relationship between Family Characteristics and the Incidence of Acute Diarrhea

Variable	Acute diarrhea (n=45)		Not Acute Diarrhea (n = 45)		P-Value	OR (95 % CI)
	f_i	%	f_i	%		
Mother's education						
Not completed in primary school	19	42,2	14	31,1	0,270	1,6 (0,7 – 3,8)
Graduated from junior high school	26	57,8	31	68,9		
Didn't finish high school						
Graduated from college						
Exclusive breastfeeding						2,8
Non Exclusive	31	68,9	20	44,4	0,019	(1,2 – 6,6)

Exclusive	14	31,1	25	55,6		
Maternal Health Behavior						2,7
Poorly	21	46,7	11	24,4	0,028	(1,1 – 6,6)
Good	24	53,3	34	75,6		
Environmental Health						3,6
Poorly	14	31,1	5	11,1	0,020	(1,2 – 11,1)
Good	31	68,9	40	88,9		

Table 2 shows that the respondent's mother's education variable has the largest p value (0.270) with a Confidence Interval past one (0.7 - 3.8), which means that there is no significant relationship with the incidence of acute diarrhea. In further analysis, this variable of maternal education will not be included in the preparation of the initial model. Environmental health variables that are not good, including clean water storage areas that are not healthy (not closed properly), family latrines that do not meet health requirements and open temporary dumps, have the greatest risk (OR = 3,6) as the cause. acute diarrhea in children aged 7-24 months. Meanwhile, non-exclusive breastfeeding practices (providing complementary foods for breastfeeding for the first 6 months) and unhealthy maternal health behaviors (not washing hands with soap after defecating or washing the child) have a 2.8 times chance of causing acute diarrhea, compared to mothers. who breastfeed their babies exclusively and have the habit of washing their hands with soap? Thus, the three variables with p value <0.05 (exclusive breastfeeding, maternal health behavior and environmental health) can be further analyzed by including them in the multivariable analysis model.

3.3 Determination of the Initial Multivariable Model (Backward Stepwise Likelihood Ratio Method)

Determination of the Multivariable Initial Model (Backward Stepwise Likelihood Ratio Method in table 3 below.

Table 3 Research Variables in the Multivariable Initial Model

Variable	Coef β	S.E	P Value	OR (95 % CI)
PEM	1,136	0,515	0,028	3,113 (1,134 - 8,547)
Low Birth Weight	1,023	0,860	0,235	2,780 (0,515 – 15,006)
Exclusive breastfeeding	0,916	0,500	0,067	2,499 (0,938 – 6,658)
Maternal Health Behavior	0,709	0,532	0,182	2,031 (0,717 – 5,757)
Environmental Health	1,280	1,020	0,041	3,598 (1,055 – 12,269)

The initial model of multivariable analysis shows that the variable LBW, exclusive breastfeeding and maternal health behavior variables have a p value> 0.05 so that at the advanced analysis stage they must be excluded from the model.

3.4 Assessment of Possible Interactions in the Initial Model

The assessment of possible interactions can be described in Table 4.

Table 4 Assessment of Possible Interactions in the Initial Model

Variable	**Coef β**	**S.E**	**p value**	**OR (95 % CI)**
PEM	0,741	1,754	0,673	2,098 (0,067 – 65,282)
Exclusive breastfeeding	1,987	0,802	0,013	7,291 (1,513 – 35,138)
Environmental Health	0,126	1,003	0,900	1.134 (0,159 – 8,093)
Low Birth Weight * PEM	0,570	1,408	0,685	1,769 (0,112 – 27,930)
Exclusive breastfeeding * PEM	-1,835	1,017	0,054	0,138 (0,018 – 1,039)
Maternal Health Behavior * PEM	-0,739	0,823	0,370	0,478 (0,095 – 2,399)
Environmental Health * PEM	1,970	1,297	0,129	7,172 (0,018 – 1,039)

The results of the analysis of the possible interactions between the suspected confounding variables and the PEM variable showed that there was no interaction between PEM and all the suspected confounding variables (p> 0.05). However, because the interaction between PEM and exclusive breastfeeding has the smallest p value (0.054), it is still included in the final model interaction possible assessment.

3. 5 Final Model Assessment

The Assessment of Possible Interactions in the Final Model is described in table 5.

Table 5 Assessment of Possible Interactions in the Final Model

Variable	Coef β	S.E	p Value	OR (95 % CI)
PEM	2,248	0,702	0,001	9,472 (2,39-37,47)
Exclusive breastfeeding	2,005	0,821	0,015	7,422 (1,49-37,11)
Environmental Health	1,428	0,620	0,021	4,171 (1,24-14,05)
Exclusive breastfeeding * PEM	-1,835	1,017	0,071	0,160 (0,02-1,17)

Model accuracy (Overall Percentage) = 72,2 %

The results of the above assessment indicate that there is no interaction between PEM and exclusive breastfeeding (p = 0.071), so the final model that is arranged is a model without interaction. The absence of interaction suggests the need to assess and control for the effects of exclusive breastfeeding and environmental health as potential confounders

3.6 Final Model Development

Final Model The relationship between PEM and Confounding Variables with the Incidence of Acute Diarrhea in the Multivariable Model Without Interaction is described in Table 6.

Table 6 Final Model Relationship between PEM and Confounding Variables with the Incidence of Acute Diarrhea in the Multivariable Model Without Interaction

Variable	Coef β	S.E	p Value	OR (95 % CI)
PEM	1,435	0,490	0,003	4,198 (1,608 – 10,959)
Exclusive breastfeeding	0,849	0,479	0,076	2,337 (0,914 – 5,976)
Environmental Health	1,417	0,622	0,023	4,126 (1,220 – 13,951)
Constanta	-2,352	0,701	0,001	0,095

Model accuracy (Overall Percentage) = 72,2 %

From the results of the analysis above, it can be concluded that children aged 7-24 months with short nutritional status because PEM have a 4.2 times chance of getting acute diarrhea compared to children with normal nutritional status or without indication of PEM, after controlling for exclusive breastfeeding and environmental health variables. Based on the opportunity function, it can be seen the magnitude of the chance of acute diarrhea based on the risk factors for PEM, by controlling exclusive breastfeeding and environmental health as confounding variables as can be seen in table 7 below.

Table 7 Chances of Acute Diarrhea Based on PEM Risk Factors and Confounding Variables of Exclusive Breastfeeding and Environmental Health

Nutritional Status	Exclusive breastfeeding	Environmental Health	$P_{(DA)}$
Short	Non Exclusive	Poorly	0,794
Short	Non Exclusive	Good	0,483

Short	Exclusive	Poorly	0,622
Short	Exclusive	Good	0,286
Normal	Non Exclusive	Poorly	0,479
Normal	Non Exclusive	Good	0,182
Normal	Exclusive	Poorly	0,282
Normal	Exclusive	Good	0,087

From table 7, it can be seen that the greatest chance of developing acute diarrhea in children aged 7-24 months in the work area of Puskesmas Ibrahim Adjie is 79.4%, with the condition of the short child's posture due to PEM, not getting breastfeeding exclusively in the first 6 months after birth. as well as with poor environmental health conditions. This condition is 9 times more than the chance of acute diarrhea if the child's nutritional status is normal, gets exclusive breastfeeding and lives in a family with good environmental health, with a chance of 8.7%. It can be seen that the more confounding variables in risky conditions (not exclusively breastfed and less environmental health), the greater the risk of acute diarrhea.

4. DISCUSSION

The results of the analysis of the relationship between the use of non-exclusive breastfeeding and the incidence of acute diarrhea showed a significant relationship between the two variables (p = 0.019; 95% CI: 1.2 - 6.6), with a risk of occurrence of acute diarrhea of 2.77 times. toddlers who receive non-exclusive breastfeeding compared to children who are exclusively breastfed. The analysis of secondary data from the 2001 Susenas also showed results that were not much different, where non- exclusive breastfeeding increased the risk of diarrhea by 3.08 times compared to toddlers who received exclusive breastfeeding.[16] Slightly different results were found in the croos sectional study in Purwokerto, Central Java, which showed a significant relationship between breastfeeding and the incidence of diarrhea in children under five (p = 0.008, 90% CI), but there was no significant relationship between exclusive breastfeeding and the incidence of diarrhea (X2 = 0.186, p = 0.667) [17]. Maternal health behavior variables measured include continuity of breastfeeding after toddlers receive complementary feeding (MP ASI), giving a salt sugar solution (LGG) to children who have diarrhea, and washing hands with soap after washing the child or after the mother defecates. The elements of this variable have been shown in several studies to be associated with the incidence of acute diarrhea. The results of the analysis of the relationship between maternal health behavior and the incidence of acute diarrhea showed a strong correlation (p = 0.028; 95% CI: 1.1 - 6.6) with the risk of developing acute diarrhea by 2.7 times in children whose mothers had behaviors. poor health (not washing hands with soap after defecating or washing the child, not giving a salt sugar solution when the child has diarrhea, and the tendency to use MP ASI as a substitute for breast milk), compared to children with mothers with good health behavior. Some respondent mothers thought that baby feces were not harmful to health, so they did not consider it important to wash their hands with soap. Several experimental studies (randomized control trials) have shown the effect of washing hands with soap on reducing shigella reinfection by 67% in Bangladesh, as well as reducing the incidence of diarrhea in children under five to 40% in Ranggon.[18] Further analysis of the relationship between PEM and acute diarrhea with multivariable analysis again showed that children with short stature due to PEM had a risk of suffering from acute diarrhea by 4.19 times (p = 0.003; 95% CI: 608 - 10.96) than children with normal body posture, after controlling for confounding variables, the mother's history of not exclusively breastfeeding and an unhealthy environmental health condition. In the relationship between the two main variables, non-exclusive breastfeeding has a role in increasing the risk of acute diarrhea in children by 2.34 times compared to children who are exclusively breastfed, although it is not statistically significant (p = 0.076, 95% CI: 0.91 - 5.98). In this study, children under five with a history of not getting breast milk and experiencing dehydration were strong predictors of the occurrence of acute diarrhea in children under five.[19]

One possible cause of this increased risk is the seepage of sewage, both households and factories that mushroom around the settlements, which pollute clean water sources that rely on dug wells. Although the number of wells dug from the sample family is small (3 dug wells: 1 in Cibangkong, 2 in the Kebon Gedang area) but because they are used for the public, the chances of spreading the source of the disease are also greater. As a comparison, research in Sleman Regency as previously mentioned shows that environmental health, which includes the factors of the distance from the water source to the place of feces, ownership of drinking water facilities and a place to dispose of feces, is a strong predictor (respectively $p < \alpha$ and OR = 2.96; 2.35; 2.22; at 95% CI: 1.47 - 5.95; 1.04 - 5.34; and 1.03 - 4.77) the occurrence of bloody diarrhea in children under five. [20] Based on the final model of Multiple Logistic Regression analysis, it can be predicted that the chance of acute diarrhea by using the Multiple Logistic Regression function formula is 79.4%, provided that the nutritional status of children is stunted due to PEM, children do not receive exclusive breastfeeding, and come from families with poor environmental health conditions. well. The chance for acute diarrhea remains only half (28.6%), if it occurs in children with short stature due to PEM, but has a history of exclusive breastfeeding and comes from families with better environmental health. The chance of developing acute diarrhea is the smallest, which is only 8.7%, if all variables are not at risk (children with height according to normal age, receive exclusive breastfeeding, and the health of the environment where they live is good). In other words, the more risk factors faced by children aged 7-24 months, the greater the chances of the child suffering from acute diarrhea.

5. CONCLUSION

PEM is a risk factor for the incidence of acute diarrhea in children aged 7-24 months, after controlling for non-exclusive breastfeeding variables and poor environmental health. The chances of this acute diarrhea are getting smaller, if the nutritional status of the child is normal, gets exclusive breastfeeding in the first 6 months after birth and the environmental health condition is good.

6. SUGGESTION

Early detection of toddlers with short nutritional status because PEM at Posyandu with the Height / U index needs to be done also in addition to the use of the Weight / U index, it is necessary to promote better health in the practice of exclusive breastfeeding, Promotion of exclusive breastfeeding is carried out long before delivery through a personal approach (visit for pregnant women to prepare themselves (attitude, behavior and mentality) as well as other family members, it is necessary to promote better health so that people in the research area pay more attention to their environmental health, especially the use of healthier family latrines (closed, or neck geese), protected temporary storage of garbage, and sewerage that is safer from the risk of contaminating clean water sources and further research is needed.

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